

Health Consultation

Weyerhaeuser Company

Plymouth, North Carolina

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US DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

Agency for Toxic Substances and Disease Registry

Division of Health Assessment and Consultation

Exposure Investigations Section

Atlanta, Georgia 30333

Statement of Issues

The North Carolina Department of Health and Human Services (NCDHHS) modeled air emissions of hydrogen sulfide from the Weyerhaeuser Company's pulp and paper mill in Plymouth, North Carolina. NCDHHS provided ATSDR with the summary results of the modeled results and asked ATSDR if the data indicated a potential public health hazard to residents in the communities surrounding the facility (1, 2).

Background

The Weyerhaeuser Company operates a pulp and paper mill in Plymouth, North Carolina.

According to the 2000 United States census, 905 people live within a one mile perimeter of the facility, and 4,403 people live within a two mile perimeter of the facility (3). The city of Plymouth, North Carolina (population 4,107) is located directly east-northeast of the facility. The age distribution of the population surrounding the facility is indicated in Table 1 below.

Table 1: Demographic Data of Residents Living Within 2 Miles of the Boundary of Weyerhaeuser Company in Plymouth (3)

| Group | Number | Percent |
|--------------------|--------|---------|
| Total population | 4,403 | 100.0 |
| Under 5 years | 365 | 8.3 |
| 5 to 9 years | 379 | 8.6 |
| 10 to 14 years | 355 | 8.1 |
| 15 to 19 years | 308 | 7.0 |
| 20 to 74 years | 2,648 | 60.1 |
| 75 years and older | 348 | 7.9 |

Weyerhaeuser provided data relating to chemical emissions from processing operations in 2001 to the North Carolina Department of Environment and Natural Resources (NCDENR), Division of Air Quality (DAQ) (4). The estimated emissions do not include those from the wastewater treatment plant. The 2001 chemical emissions from processing operations of the facility include the following: ammonia, 221,490 pounds/year; carbon disulfide, 954 pounds/year; hydrogen chloride, 462,060 pounds/year; hydrogen sulfide, 35,146 pounds/year; methyl mercaptan, 21,192 pounds/year; and sulfuric acid, 61,394 pounds/year. Emissions of total reduced sulfur (TRS) were 180,514 pounds/year.

Air Modeling Results

In January 2003, the NCDHHS requested modeling data of total emissions of hydrogen sulfide, including both emissions from the waste water treatment plant (WWTP) and emissions generated by the processing operation. The total hydrogen sulfide emissions of from the facility were estimated to be 3,635,400 pounds per year, and 99 percent of this total comes from the WWTP. Using this total emission rate, the NCDENR used the Industrial Source Complex (ISC3) model to estimate ambient air concentrations of hydrogen sulfide in the surrounding areas. Based on the data provided by Weyerhaeuser, NCDENR estimated a maximum 1-hour hydrogen sulfide concentration of 15,000 micrograms/m³ and a maximum 24-hour concentration of 2,565 micrograms/m³ at the property line of the facility.

Using ISC3 air modeling, NCDENR also calculated off-site ambient air concentrations of hydrogen sulfide. They estimated that within a radius of 25 miles from the facility, the 1-hour ambient air hydrogen sulfide concentration would exceed the NCDHHS and North Carolina Scientific Advisory Board-recommended 1-hour level of 56 micrograms/m³ (40 ppb) an average of 30 times a year. Within a 9.3 mile radius of the facility, NCDHHS estimated that the 24-hour ambient air hydrogen sulfide concentration would exceed the NCDHHS and North Carolina Scientific Advisory Board-recommended 24-hour level of 33 micrograms/m³ (23 ppb) an average of 22 times a year. NCDHHS has recommended that these values be adopted as Acceptable Ambient Levels (AAL) for hydrogen sulfide within the State. The 1-hour standard was based on protecting asthmatics from bronchial obstruction. The 24-hour standard was based on protecting the general public from eye pain and visual disturbances. A copy of the North Carolina Scientific Advisory Board's paper, including calculations and references used to derive these levels is attached (5).

Limitations of Air Modeling

Limitations in using ISC3 air modeling to predict ambient air concentrations of hydrogen sulfide include the following:

1. Hydrogen sulfide is heavier than air, and the model does not account for dispersion of a gas heavier than air.
2. Hydrogen sulfide is reactive, and the model does not account for losses of hydrogen sulfide that may occur by chemical oxidation reactions in the air. The atmospheric residence time of hydrogen sulfide is typically less than one day (5).
3. Emissions may vary over the course of a day or between seasons, whereas the model assumes steady-state (constant) releases.

In addition, predictions from Gaussian plume models, such as the ISC3 model used in the above calculations, contain inherent uncertainty that increases with distance from the source. For example, on flat landscapes with receptors within 6 miles of the source, an uncertainty factor

of 2 may apply for long-term averages (6). For sites with complex terrain or coastal meteorology, an uncertainty factor of up to 100 may apply. Therefore, actual air levels of contaminants could be considerably higher or lower than the modeled levels.

Discussion

Air modeling results indicate that residents living around the Weyerhaeuser paper pulp mill in Plymouth may be exposed to atmospheric hydrogen sulfide concentrations that exceed health-protective levels recommended by NCDHHS and the North Carolina Scientific Advisory Board. Short-term exposure to high concentrations of hydrogen sulfide in air may result in bronchial obstruction in asthmatics leading to increased asthma symptoms as well as visual disturbances and eye and nose irritation (7, 8, 9). To protect against such effects, North Carolina has recommended a 1-hour AAL of 56 micrograms/m³ and a 24-hour AAL of 33 micrograms/m³. The air modeling conducted by the state estimates that the hydrogen sulfide concentrations at the property line would exceed the NCDHHS and the North Carolina Scientific Advisory Board recommended concentrations by several hundred times. It is predicted that the recommended maximum concentrations will be exceeded in five counties, including Chowan, Bertie, Martin, Beaufort, and Washington counties, at distances up to 25 miles from the facility, as shown in Figure 1 (10).

Figure 1. 1-Hour Impact Area and Counties



Even if the uncertainty in the model predictions were factored in, off-site ambient air

concentrations of hydrogen sulfide are still predicted to exceed NCDHHS-recommended levels and North Carolina Scientific Advisory Board-recommended AALs.

ATSDR derived an acute minimum risk level (MRL) for hydrogen sulfide of 97 micrograms/m³ (70 ppb). The acute MRL was based on a study of hydrogen sulfide-induced bronchial obstruction in asthmatics. ATSDR also derived an intermediate minimum risk level of 42 micrograms/m³ (30 ppb). The intermediate MRL was based on a study of nasal irritation in animals. ATSDR's acute MRL is for an exposure period of 14 days or less, and its intermediate MRL is for an exposure period of 15-364 days. The maximum 24-hour concentration of hydrogen sulfide at the facility property line (2,565 micrograms/m³) greatly exceeds ATSDR's acute MRL (97 micrograms/m³). Therefore, it is likely that in off-site areas near the facility, short-term hydrogen sulfide levels exceed ATSDR's acute MRL. Additional modeling or monitoring data are needed to assess the health impact of longer-term exposures to hydrogen sulfide in areas near the facility.

Other chemicals identified in emissions from the facility (carbon disulfide, ammonia, hydrogen chloride, sulfuric acid, methyl mercaptan, and total reduced sulfur) may also be affecting ambient air quality in the area. For hydrogen sulfide, about 99 percent of the emissions are thought to originate from the waste water treatment plant and about 1 percent from process operations at the facility. The relative contribution of waste water treatment operations to the total emissions of the other chemicals is unknown, so it is not possible to estimate off-site ambient air concentrations of these chemicals.

Children's Health Considerations

ATSDR recognizes that in communities faced with contamination of their air, water, soil, or food, the unique vulnerabilities of infants and children demand special emphasis. ATSDR is committed to evaluating the health impact of environmental contamination on children. As shown in Table 2, the asthma hospitalization rates for children 0-14 years in four out of the five counties within the 25-mile impact radius are higher than the state asthma hospitalization rate. The role, if any, that Weyerhaeuser emissions have on this health outcome remains to be determined.

Table 2: 2001 asthma hospitalizations of children 0-14 years for counties within the 25-mile impact radius. Rates of hospitalizations are per 100,000 children. Numbers are based on hospital discharge reports (10, 11)

| | Number of Children 0-14 Years | Rate for Children 0-14 Years |
|-----------------------|-------------------------------|------------------------------|
| North Carolina | 3,415 | 203 |
| Chowan | 7 | 249.5 |
| Bertie | 11 | 268.2 |
| Martin | 10 | 192.4 |
| Beaufort | 20 | 231.9 |
| Washington | 9 | 319.3 |

Conclusions

- (1) Based on air modeling results, residents living around the Weyerhaeuser paper pulp mill may be exposed to ambient air concentrations of hydrogen sulfide that exceed health-protective levels recommended by the North Carolina Department of Health and Human Services and the North Carolina Scientific Advisory Board. Modeled 24-hour hydrogen sulfide concentrations also exceed ATSDR's acute minimal risk level for hydrogen sulfide.
- (2) Because no actual ambient air monitoring data are available, the Weyerhaeuser pulp and paper mill is classified as an indeterminate public health hazard.

Recommendations

- (1) Conduct air monitoring in residential areas near the facility to better define the ambient air concentrations of hydrogen sulfide that people are being exposed to.
- (2) Review available information on potential releases of other site-related chemicals from non-process sources at the facility (e.g., the waste water treatment plant) to determine if off-site ambient air monitoring for other site-related chemicals is indicated.

Public Health Action Plan

- (1) The North Carolina Department of Health and Human Services will submit a proposal to ATSDR's Exposure Investigation Section to conduct ambient air monitoring for chemical emissions from the Weyerhaeuser paper pulp mill.

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